# Environmental Factors Contributing to Burn Severity on Three Large, Multiday Forest Wildfires Across Central Idaho and Western Montana, 2005 to 2007

Donovan S. Birch[1], Penelope Morgan[1], Greg K. Dillon[2],
Crystal A. Kolden[3], Andrew T. Hudak[4], Alistair M.S. Smith[1]

[1] Dept. of Forest, Rangeland, and Fire Sciences, College of Natural Resources, University of Idaho, Moscow, ID
[2] USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, Missoula, MT
[3] Dept. of Geography, College of Science, University of Idaho, Moscow, ID
[4] Rocky Mountain Research Station, USDA, Forest Service, Moscow, ID

University of Idaho
College of Natural Resources

## 1) Abstract

Burn severity as measured by satellite-derived differenced Normalized Burn Ratio (dNBR) has been used in many studies and applications of management. Burn severity is controlled by many factors of the fire environment. We used Infrared (IR) perimeter maps on three large wildfires in central Idaho and western Montana from 2005 to 2007 to locate areas that burned in 24 hour periods. Using these known locations we selected 31 topographic, fuels, and weather variables. Using the Random Forest machine learning algorithm we examined which variables had most the most influence on dNBR. We found that the percent vegetation cover had the largest influence on dNBR, with 6 variables offering the best model ($R^2 = 0.5159$).

## 2) Introduction

- Extent and frequency of wildland fires in the western United States have increased with recent climate changes (Littell et al. 2009; Westerling et al. 2006)
- High severity fires consume large amounts of biomass (Keeley 2009) and have long-term ecological effects on vegetation structure and composition (Holden et al. 2006; Lentile et al. 2007)
- Burn severity can be seen as the degree of change one year post fire (Lentile et al. 2006)
- Multiple factors of the fire environment interact to produce burn severity
- Differenced Normalized Burn Ration (dNBR) provides an accurate detection of burn severity in forested ecosystems and has been used in many applications of management

**Question**

**What environmental factors, such as topography, fuels, and weather, influence burn severity in forested systems?**

## 3) Methods

**Study Area**
- Central Idaho and western Montana
- Large multi-day wildfire
- 2005 to 2007

**Data Selection**
- Infrared (IR) daily perimeter progression maps used to locate specific areas of growth of three fires
  - ◊ IR map of 'day 1' — IR map of 'day 2' = areas that burned in 24 hours (See Figure 1, Red Mountain Fire)
- 18,400 ha and 25 days of fire progression for the three fires
- 1740 random sample points in forested areas

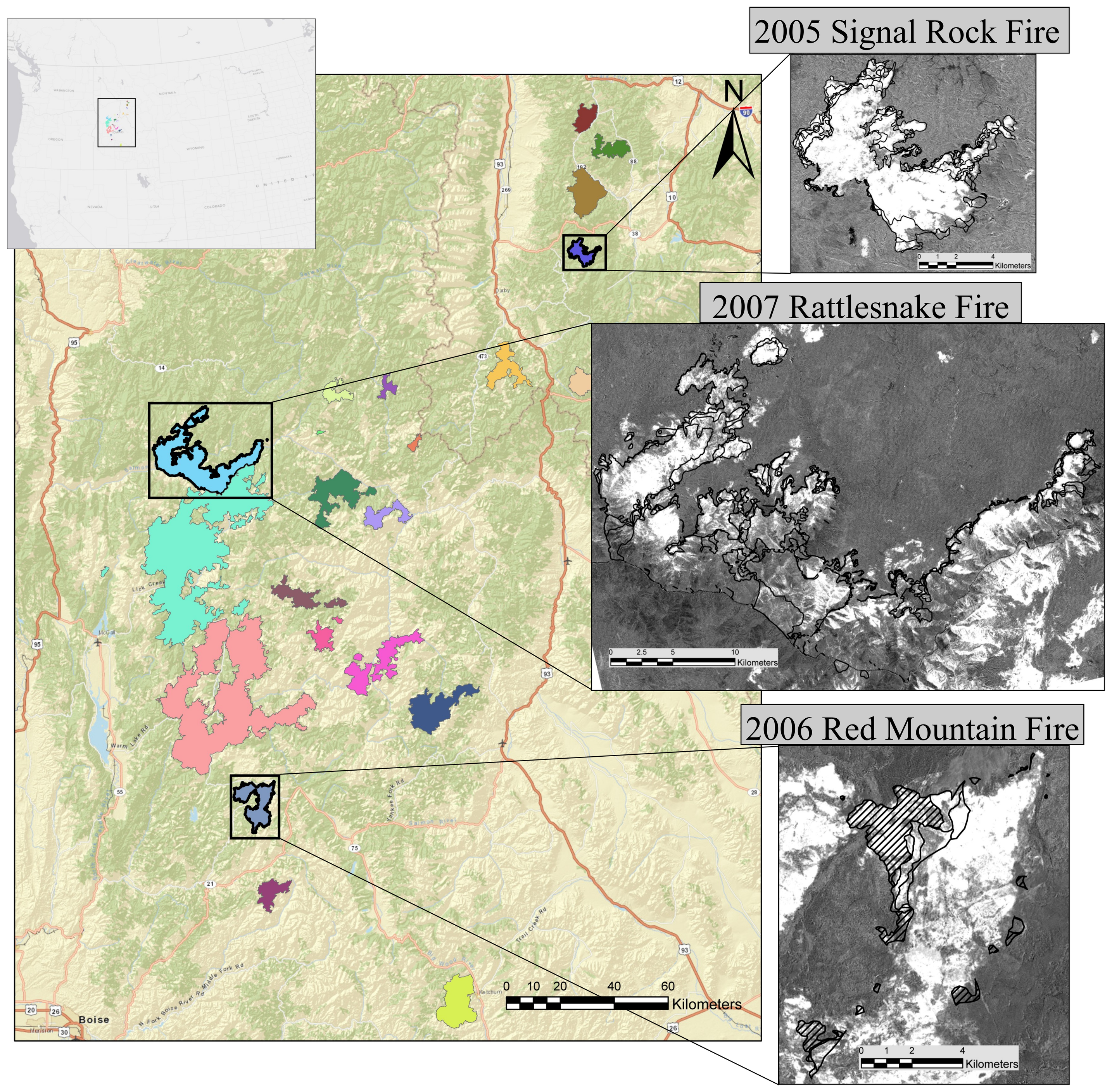


**Figure 1.** Study area. Includes 27 other fires that will be used to further this study. The three highlighted fires were chosen based on representing the larger project by covering across the study area and study years. Note: Hatch marked areas of 2006 Red Mountain Fire show individual areas burned on Sept. 4 as indicated by daily IR perimeter maps of the fire.

## 3) Methods (continued)

- 34 initial collected variables
  - ◊ 9 - Fuel layers obtained from LandFire
  - ◊ 15 - Topographic variables based on DEM
    - Fuels and Topographic variables on 30 m scale
  - ◊ 10 - Daily weather data at 4 km scale
    - Based on the 24 hours from IR maps
- Highly correlated variables removed (Spearman's rho $\geq$ 0.75)
- **31 predictor variables**
  - ◊ **12 Topographic**
  - ◊ **9 Fuels**
  - ◊ **10 Weather**
- Continuous dNBR data obtained from Monitoring Trends on Burn Severity project

**Analysis**
- Random Forest
- 31 predictor variables covering topography, fuels, and weather
- Both categorical and continuous datasets
- dNBR response variable
- 7500 regression trees

## 4) Results

- 6 variables offered the optimal model ($R^2 = 0.5159$)

1. Percent Vegetation Cover
2. Elevation
3. Latitude
4. Longitude
5. Daily Maximum Temperature
6. Burning Index

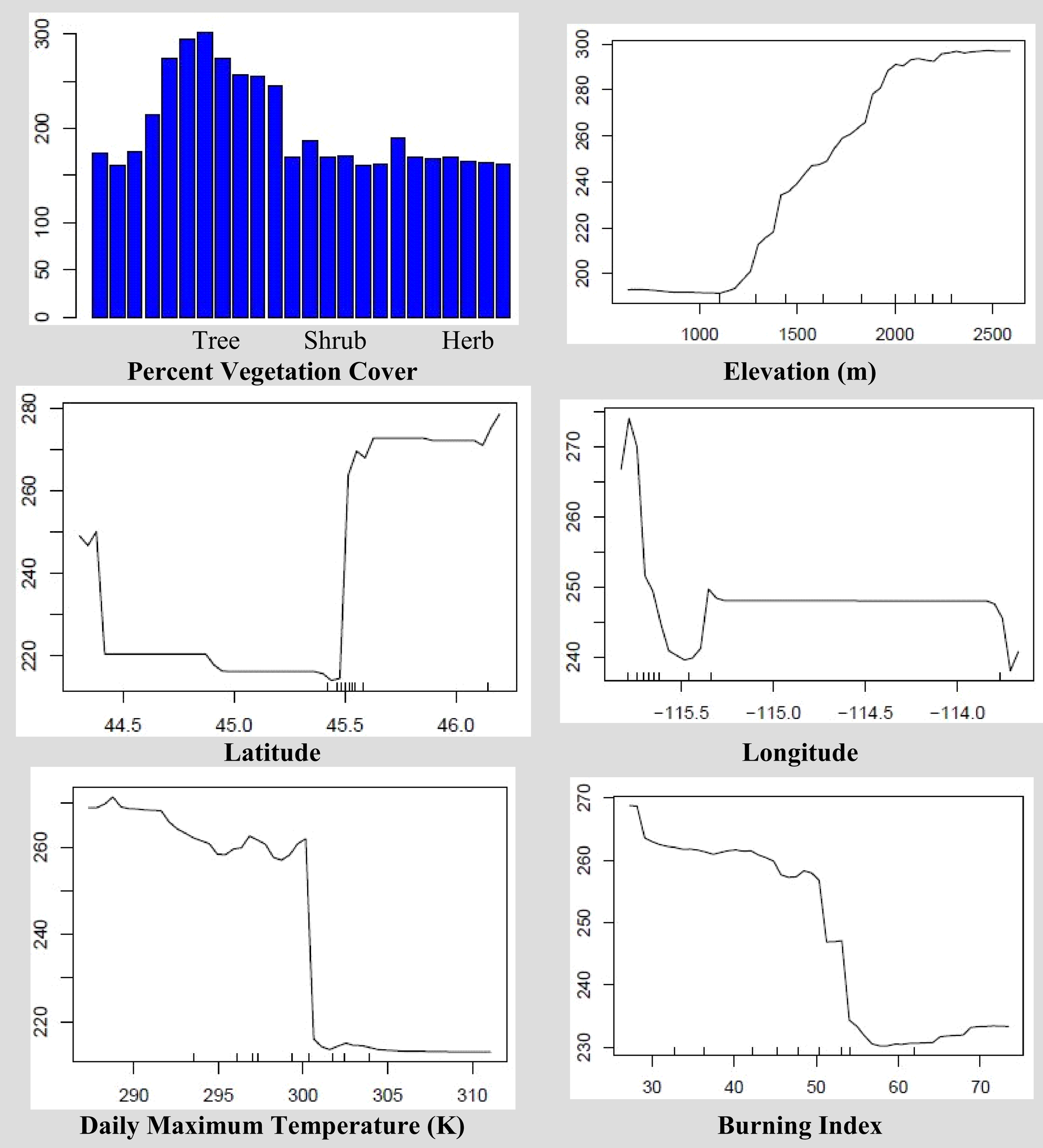


**Figure 2.** Random Forest partial dependence plots for the six optimal model variables. Plots indicate the dependence of the probability of dNBR on one predictor after holding all other predicators in the model at their average. Range of Y-axis numbers is important not absolute values.

## 5) Conclusion

Percent vegetation cover of trees has the largest influence on dNBR. Multiple other weather and topographical variables contribute to the variability in dNBR. This study is part of larger analysis of 30 fires that burned during the 2005 to 2011 fire seasons in central Idaho and western Montana. We will test how these 33 variables change compared to 'normal' and 'extreme' fire years, such as 2007. We will test the hypothesis that local fuels and topography have a bottom-up influence on where fires burn severely, while climate and weather have a stronger top-down effect on daily areas burned.

**References-**

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